SUPPLEMENT.

The Mining Journal,

RAILWAY AND COMMERCIAL GAZETTE:

FORMING A COMPLETE RECORD OF THE PROCEEDINGS OF ALL PUBLIC COMPANIES.

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ON SLATE AND SLATE QUARRIES.

BY S. R. PATTISON, F.G.S.

Part Second—Slate Quarries.

The principal slate quarries in the world are those of North Wales, and of these the chief places must be assigned to Penrhyn and Llanberis. From afar the workings of each of these are visible, glittering in the sunshine on the mountain side, a cataract of slates falling in successive steps from the summit to the foot of the slope. The metropolis of the Penrhyn district is Bethesda. Why the name of the pool at the sheep-gate of Jerusalem should have been given to this village on the River Ogwen does not appear. Probably it was the choice of some good man, more learned in scripture than in British etymology. At Bangor, the numerous public conveyances for Bethesda assure the traveller that the latter is a place of considerable importance; the cause is explained by the wagons and rattling wains filled with slate, which he meets on his upward way. The town has grown up from a roadside hamlet into all the apparatus of municipal prosperity. Everything is Welsh. The signs, the advertisements, the newspapers, the books. It has a large population, entirely dependent on slate-quarrying. Soon after passing Bethesda, proceeding up the stream of the Ogwen, the great works which have made minor mountains in front of the original hills, become visible on the opposite bank. The most conspicuous building is a hospital; the next, public schools. The debris of the quarry near the river is sufficiently ancient to sustain the growth of venerable trees and tangled underwood. Through a fragment of such woodland the visitor is introduced to the excavations, and finds a guide always at his service. The works are carried on both above and below the level of the original surface The latter works are first reached. You stand on the brink of an open pit, with irregular sides, jagged with projections of slate rock. Above you and in face rise successive scarpings of the mountain side. The horizontal lines which, at a distance, appear to stretch like cobwebs at even intervals across the upper workings, are now discovered to be platforms, running from end to end, each forming the base of a separate quarry, along which is a tramway, on whose lines horses and trucks are visible. Between these lines, on the vertical face of the rugged rock, men work suspended, protected by ropes slung from the platform above, detaching blocks of slate rock, which fall or slide on to the platform below, and are then removed to the wings, where the slate blocks are selected, and the rubble tilted over.

In the Penrhyn Quarries the prevailing colour of the slate is greyish purple. The green colours occur in veins, and are more highly valued in the market, for better chromatic effect in architecture. These quarries have quite an ancient appearance, although the daily removal of so many hundred tons of rock is constantly exposing fresh faces of stone to the light of day. They have been worked so long that the buildings and belongings, embowered in trees, do not interfere with the picturesque character of the scenery. Time has thrown his wonted adornments over the ruined cliffs. Both at Penrhyn and Llanberis there is a completeness of organisation which speaks of long-continued establishment. The hourly wind of the horn, reverberating through the works, announce the simultaneous firing of the "shots" of powder in explosion, so that all may get into a place of safety. The lull of the thousand hammers, the men moving to shelter, the dull "thud" of the blasts, the echoes rolling up the valley, the fall of fragments, the resumption of labour, and busy clinking of the tools, have been hourly occurrences for very many years. To the workmen it must almost appear like the course of nature. The sight of the hospital betokens some incidental dangers, but, on the whole, the process of slate quarrying is much less dangerous than mining. After leaving the quarries, the traveller proceeds up Nant Francon, up to the crags of the Glidwrs, the glassy surface of Lake Ogwen, the peaks of Snowdon, still pursued by the sound of blastings, and ere they have died away at the head of the pass he encounters the echoes of similar sullen sounds from the Llanberis side. The thunders which accompanied the original deposition of the volcanic productions around are being again evoked, and doled out, as it were, in measured time by the works of the quarrymen. The Penrhyn Quarry is said to date from the days of Queen Elizabeth. In the year 1765 the number of men employed was 80, a century afterwards it reaches 3000. The royalty originally paid to the Pennant family was one-eighth, commuted in 1765 for 80*l.* per annum. In 1782 Lord Penrhyn took the working into his own hands. The profits in recent years are said to have been 60,000*l.* per annum, but this estimate is quite unreliable. The make of slates is 10,000 tons per month. They are sent down to Bangor by tramway, and shipped there, hence they are known in commerce as Bangor slates.

The Llanberis Quarries are still more romantically situated than the Penrhyn. The vale of Llanberis is in the immediate presence of Snowdon, and on the margin of the lake of Lyn-Peris. They are on the same vein as the Penrhyn, only a few miles apart. Professor Sedgwick's section of the quarries will convey an idea of their nature better than pages of description; it will be found in the Quarterly Journal of the Geological Society, No. 10, p. 138. The great quarry at Llanberis is that of Dinorddwig, the property of the late Assheton Smith. It has been wrought with great skill and care, and is in every respect the model slate quarry of the world. The monthly make of slate is about 7500 tons, the number of men employed about 2500. The produce is sent by rail to Port Dinorwic. Adjacent to the quarry is a factory for making writing slates. Grouped around the centres of Bethesda and Llanberis are many other quarries. A few of them are enumerated below, and an approximate estimate given of their workings, but this is a quantity continually variable:—

		Men.	Make in tons per month.
Bethesda District	–Pantdreinog	100	300
,,	Bangor	250	600
Llanberis District	–Glymtronwy	150	400
,,	Cefndu	45	100
,,	Various young quarries.		
On the Nant	—Nant-y-Bettws (four quarries).		
,,	—Moel-tryfan (four quarries).		
,,	—Cilgwyn	200	500
,,	—Dorothea	370	800
,,	—Penybryn	300	600
,,	—Penyorsedd	450	420
,,	—Talysarn	—	—
,,	—Coed Madoc	—	—
,,	—West Dorothea	95	170
,,	—Tymawr	43	75
,,	—Various young quarries.		

There are several new quarries between Nantile Vale and Port Madoc.

The next district of North Wales which has become renowned for the magnitude and excellence of its quarries is that of the beautiful vale of Festiniog. The principal quarry is that belonging to the Welsh Slate Company, better known as Lord Palmerston's, because his lordship was a principal proprietor. It is said to be the most productive, for its area, of any quarry in Wales; and the most profitable, because requiring but comparatively small capital. The number of men employed is about 450, and the make of slates about 2000 tons monthly, producing a profit exceeding 30,000*l.* per annum. Other quarries in the district are:—

Rhiwbrfdir, making per month about	Tons	1200
Messrs. Hollands'	ditto	800
Llechwedd	ditto	950
Rhiwbwh	ditto	400
Diphwys	ditto	500
Percival's	ditto	450
Maenofferan	ditto	70
Cwmarthin	ditto	120

But these are constantly varying in number and produce. Mr. Sharpe's section of the rock at the Festiniog Quarries is as follows, in descending order:—

		Feet
Mr. Holland's Quarry. Quarry Welsh Slate Co.	Dark-blue slate	25
	Blue slate, too hard to work	120
	Hard grey hornstone	1
	Dark-blue slate, of good quality	150
	Blue slate, too hard to work	120
	Hornstone	18
	Poor slate	3
	Hornstone	6
	Dark-blue slate, of the best quality	150
	A whinstone dyke	—
	Schists	500
	Slate quarried	100
	Schists	600
Upper Diffws.	Alternations of hornstone and slate	30
	Poor slate	10
	Good blue slate	50
	Schists (about)	102
	Whinstone	—
Lower Diffws.	Slate, too hard to work	50
	Slate, of middling quality	100
	Good slate	60
	Schist and hornstone	500
	Semi-crystalline quartz rock	100
	Greenstone	—
	Light-grey slate, indifferent quality	150
	Total thickness, exclusive of igneous rocks	2910

(Poor slate below.)

The mode of working slate in the Festiniog district differs from that in Carnarvonshire, by reason of the lower angle of the beds, which requires that they should be followed into the superincumbent hill, in mine galleries. Prof. Ramsay gives an instructive section of one of the Festiniog quarries, serving to illustrate at once the mode in which the vein occurs, and the method of extracting the slate. For it I must refer to the woodcut at p. 76 of his work. The quarry was opened at the surface, the vein followed first by enlarging the pit on all sides, then by taking down the head overlying the vein; but, as the rock dipped at about 35° into the hill, the time soon arrived when it cost more to remove the top, in order to get at the vein, than the latter was worth for produce. The vein in the present case was very good, and the containing rock very hard, so that a system of mining was used, instead of quarrying. The vein was followed, and the superincumbent strata propped up by pillars left in the work. This operation will continue until the distance into the end becomes so great that the cost balances the worth of the slate. This instance shows how, even in the course of a vein of profitable slate, a quarry may be practically worked out. Profit cannot, of course, be realised without a good vein of good slate; but, even when this is present, the profit depends on other conditions, such as the nature and condition of the top rock, the slant of the beds, and, lastly, the facilities for sale and shipment. There are many paying quarries in the Festiniog district worked on the gallery and chamber system. The quantity of profitable slate in the whole of the vein in the Festiniog district varies from one-half to one-third, excluding, of course, the top and the containing strata. Hence arises the vast piles of rubble, and hence the great uncertainty attending the opening of a new quarry, for the proportion of the wholly unprofitable rock to be first removed, and then of the profitless portion of the vein to be also lifted and removed, cannot be ascertained with accuracy except by actual experiment. There is no doubt that experiments might be made, for an approximate result, at a comparatively small expenditure. But the frequent practice of quarry-owners and agents is to indulge and express sanguine expectations, to raise and expend a large capital in works laid out for permanence, before simply testing the commercial value of the vein. Prof. Ramsay cautiously says:—"It is to modifications on a large scale, induced by change of lithological structure, and position of the strata, that the availability of the same set of beds for slate-making depends in different localities." (Page 76.)

[*To be continued in next week's Mining Journal.*]

On the Occurrence of the Mineral Scheelite (Tunsgate of Lime) at Val Toppa Gold Mine, near Domodossola, Piedmont, by Mr. C. Le Neve Foster.—The author stated that scheelite is now occurring at the Val Toppa Gold Mine. It is associated with quartz, iron pyrites, galena, zinc-blende, calc-spar, brown spar, and native gold—whilst wolfram, tinstone, molybdenite, topaz, apatite, fluor-spar, and tourmaline, which usually accompany scheelite, are entirely absent. The scheelite is called *Marmor rosso* (red marble) by the Piedmontese miners, and is looked upon as a good indication for gold.

Coal Mining in China.—Professor Bickmore, in a lecture on the Minerals of China, at the American Association for the Advancement of Science, said that Coal was used for fuel ages before its properties were known to Europeans. Marco Polo, the great Venetian traveller, who visited Pekin more than 600 years ago, found it in common use. The only mode of transporting this mineral in the northern parts of China is on the backs of camels, mules, and donkeys. The Professor described a mine in Pekin, which he descended for a mile, being obliged to crawl on his hands and knees, as the height of the adit or tube was only 4 or 5 feet. The coal is drawn up in baskets on sleds, each basket holding from a peck to half-a-bushel. The only covering of those who drag it up is a thick layer of coal dust. The slow and labourious mode of taking the coal to the surface is the only one Prof. Bickmore saw in the mines he visited; neither are there any adits or tunnels for the admission of pure air. Accidents from the explosion of fire-damp rarely or never occur, however, probably because the Chinese are unable to dig lower than the water level for want of proper pumping apparatus. For the same reason the best coal in China remains as yet undisturbed, and awaits the enterprise and improved apparatus of Western nations. Coal occurs from place to place over the whole empire. It is overlaid with a red sand-stone, and the Chinese commence their operations when the strata chance to outcrop, and follow them down at whatever angle they chance to lead. Prof. Bickmore also showed by extracts from ancient works that petroleum was not only known but "used for lamps" more than 160 years ago. The Chinese name for it is "Oil of Stone," which, as is well known, is identical with our name petroleum.

THE NATIONAL IRON AND STEEL INSTITUTE.

THE MANUFACTURE OF RAILS—THE IRON RAIL TRADE.

Mr. Edward Williams (Middlesborough) read a valuable paper upon the Manufacture of Rails. He said he proposed to give, as concisely as he could, the opinions he entertained as to rails, and to consider, from the stand-point of a rail-maker, the several kinds of rails in use, the merits and demerits of each, together with the processes of manufacture generally used. The paper said—The rails of to-day are of two distinct kinds—those made from ingots, and those built-up; and it must be admitted that (questions of cost and possible supply not considered) ingot-made rails are best. We are in the habit of describing the two kinds as steel rails and iron rails—a description obviously incorrect—because the Bessemer rails now making have a percentage of carbon much lower than that of steel proper as we used to know it. Besides, it is, so far as I know, impossible to define when iron ends and steel begins. It will, then, be as well to call the two divisions ingot rails and piled rails. For many years makers of iron by the old processes have desired and endeavoured to produce ingots or blooms, each from a single puddled ball, that would roll into rails. This, if it could be done, would I have no doubt make rails equal to any ever made; but the difficulty seems insuperable. Puddled-balls of sufficient size have been and may be obtained; but it appears impossible to produce moderate compactness of the iron without more work upon it than is possible in one operation. I have come to the conclusion, though most unwillingly, that we shall not succeed in producing by puddling workable, unwelded, solid blooms; and, so far as our present knowledge extends, ingots cheap enough to make rails on a considerable scale are only to be obtained by the Bessemer process. Whether or not the Siemens-Martin process can compete, in point of cheapness of production, with the Bessemer process is yet unproved, and the question need not arise here. It is sufficient now to know that both can, without doubt, produce ingots that roll into rails without much difficulty, and that such rails, being free from the possibility of lamination, must be more enduring than built-up or piled rails, however carefully made. It is not unlikely that further experience may determine the precise constitution ingots should have to produce the most enduring rails, but at present this is matter of opinion only. The freedom from welds and layers is an enormous advantage, and the use of ingot rails will, I feel sure, go on increasing, though the rate at which they will push piled rails out of existence must, of course, depend on their relative costs. If the phosphorus difficulty could be got over, and the cheap pigs of the Cleveland district were available for the Bessemer process, there would be so great a reduction of cost that ingot rails would be almost as cheap as piled ones, and the latter must at once give way; but there is not at present any good ground for expecting that such a change is near, and I see no reason to suppose that for some time to come ingot rails will become anything like universally used, because of their price. The removal, in February next, of the bulk of the present Bessemer royalty charge will, no doubt, reduce the selling price of ingot rails; but I am mistaken if, after all, they can be produced so as to be sold within 40*s.* or 50*s.* per ton of the average selling price of good piled rails, the life of which, in the ordinary portions of a heavily-worked railway, would be about fifteen years. For the very severely-worked places ingot rails, at almost any moderate extra price, are, of course, best. Strenuous efforts have been made by nearly all the great ironmakers everywhere to produce steel-topped rails, which, it was hoped, would be much more lasting than the usual piled iron rails, and less costly than ingot rails. Puddled steel seemed to offer a cheap and good material for this, and, after some difficulty to begin with, it was produced of uniform quality. It is, no doubt, a material capable of resisting well the wear and tear of railway stock, but it could scarcely be welded at all, and, as it could not be obtained in solid blooms of the rail size, the system failed, and has been abandoned, in this country at least, entirely. That Bessemer steel slabs can by great care and skill be so fastened to iron as to make rails that will wear well is proved by the instances of the rails supplied to the Edinburgh and Glasgow Railway, and to the Swedish Government. Probably there have been some other instances also, but I do not expect to find such rails coming into general use, because of the difficulty of welding on the steel plate, which is not much, if at all, less than that of the puddled steel before spoken of. It need not be told to this meeting that steel, however mild, will only stand a comparatively low heat, while iron, to weld at all, must have a high one. Giving the steel top a mechanical grip is, no doubt, to make the best job possible, but the channel steel slab has the disadvantage that the horns prevent the escape sideways of the superfluous cinder, which at best interposes too much between the layers to be welded together. This could not fail to produce faulty welding, which the traffic of an English railway, such as the North-Eastern, would certainly bring to light, despite the mechanical fastening. So far as I can see, then, the only choice as to the rails lies between those made from ingots and piled ones, and in the uncertainty as to the Siemens-Martin process it may be assumed that the Bessemer process will supply the former. I do not desire to convey any doubt or even opinion as to the practical value of the Siemens-Martin process; but it is not yet, in England at least, in operation for rail-making on more than an experimental scale, and it is, therefore, uncertain what proportion of the rail ingots of the future it will supply. The present price of ingot rails is about 10*l.* per ton for usual flange sections, and it is, I believe, the fact that this is not remunerative. After February next makers will save most of the royalty for patent right, and it may be assumed that rails will go down (say) to 9*l.* per ton. While ingot rails are at anything like this price, good piled rails, the average selling price of which is not 6*l.* 10*s.* per ton, and which, under moderate traffic, would live, on the average, fifteen years or more, will, I believe, hold their ground, and be in demand. I wish to make it clear that my remarks apply only to good iron rails; the very lowest kind is only bought by those who give themselves no concern as to quality, and first cost will in such cases be the only consideration. It is not unfrequently asserted that, as a rule, the rails (of course, all piled rails) of twenty years or so ago were of a more enduring kind than those supplied now, and I think there is some truth in the accusation. It must not, however, be forgotten that the duty imposed on rails now is very much in excess of that they had to bear in the early days of railways; and that, therefore, mere length of life is not a correct standard by which to measure their quality. As the weight upon the rail increased, engineers and manufacturers simultaneously adopted the use of more fibrous iron as a preventive. Still every now and then a rail would break, despite the extra endeavour to prevent it, and notwithstanding the heavy and heavier tests which rails were required to stand. This has gone on for many years, until not a few of the specifications framed by engineers, certainly with the view of ensuring excellence of quality, bring about the reverse, because to meet them rails are made of fibrous, and, therefore, difficult welding iron, at an increased cost, and less serviceable than those made after a simpler system. Even, after all the additional cost and the diminished value of the tougher rails, there is an occasional breakage (as there is also now and then a breakage of ingot rails), and I am of opinion that it will be so, despite all possible care, and irrespective of price. We all know that a percentage of piles or ingots heated are, even by the best workmen, so over-heated, at some stage or other, that they fall into pieces, or become torn in the rolls; there are also, no doubt, some which are heated a shade short of this point, and just hold together, but are almost as brittle as porcelain when finished. This occurs while the great bulk of the rails are abundantly strong, and I do not see how any system of testing can detect the unfortunate instances. They cannot under any tolerable supervision be more than a small proportion—under good watching very small; but I am afraid they will always be a proportion, as there is in the case of crucible steel tires, which cost eight or ten times as much as rails, and which have all possible care and skill devoted to them. Supposing the all-but-broken rails to be 1 in 100,000, it will be evident that there is small chance of that one being selected for testing, and if it were chosen it would be found so exceptional that nothing more serious would follow than the testing of a few more rails to prove that it was exceptional. I do not at all advocate the discontinuance of the system of testing rails—no prudent maker would abolish it, even though it were insisted on; but it is, I am sure, the fact that the excessively heavy falling weights, prescribed frequently, do necessitate the use of iron for rails that welds with difficulty, and, therefore, does not make the best rail for wear. To meet the severe falling tests, it is absolutely necessary to use fibrous iron, and not to heat too much; in fact, to make the piles of iron that, do what you will, is very difficult to weld, and then not to give them the amount of heat necessary to make as good a weld as might be. On this subject I have thought and experimented much, during a somewhat long experience, and I am satisfied that a fibrous nature and weldability do not go together, and that only well-puddled crystalline iron welds easily, and, therefore, with moderate certainty. Given any kind of wrought-iron, it welds more easily in its first stage, that of puddled bar, than at any future one; and the effect of roughing it down—that is, of extra piling and rolling—is always to diminish the weldability of the resulting rail piles. Those who make cable-bolts, best boiler-plates, and other similar iron, know how certainly they are spoiled if they are worked very hot—in other words, if they are welding hot. Cable-bolts for a chain are not the worse, but the tougher

and softer, because the layers of which they are composed are only firmly struck together, and not welded; but in rails welding is the very life itself. As often as opportunity offered I have carefully examined rails that had borne an unusual amount of work before becoming so worn as to be replaced, and in, I think, every instance they were what we now would call very brittle rails, and had a rough crystalline fracture when broken under a falling weight. It is, I think, undesirable to use rail piles of great cross sectional area, which are less likely to be heated equally to the centre than were the small piles of a quarter of a century ago. Rails at present are heavier and longer than formerly, and it would not, I presume, do to go back to piles 6 in. square, or thereabouts; it would, however, I think, be well not to exceed 6 in. by 8 in., which, with blooming and double heating, might be well welded. The two great rail-producing districts of this country are Wales and the North of England, and each has a system of working different from the other. These systems having been explained in detail, and with the aid of diagrams, Mr. Williams went on to say that the Welsh system has the merit of more work on the iron—that is, greater consolidation than is obtained by the North of England system. This is a doubtful advantage, if it is really, as I believe, that the iron for rails is, as a rule, too much worked, whilst it has the demerit of having many through welds in the heads of the rails. The North of England system produces hard crystalline heads, with the fewest possible welds, and when the iron of this district is not too much worked, and thus made fibrous, it is of the most weldable kind, though somewhat brittle. Such iron, it seems to me, is likely to produce enduring rails, and I firmly believe that with proper attention piled rails can, and will, for a long time yet be made from it, so enduring as to compete successfully with good ingot rails, produced by the Bessemer process. Mr. Williams concluded: My desire has been to lay before those who make and those who use rails the conclusions my experience has produced as to the causes of the unsatisfactory wearing power of piled rails, and to show how, in my opinion, the evil may be abated. The subject is very important to all, and to no class of men more so than to those who, like myself, make piled rails. These are now in competition with ingot rails of the Bessemer process, and cannot, I think, possibly continue in demand, unless the greatest care be given to the manufacture, both as regards the iron used and the welding. Welding I hold to be the one thing needful, and we should never lose sight of it. As I have before said, the chance of obtaining thorough welding would be much increased by not insisting on more toughness and fibre than is absolutely necessary to guard against so much brittleness as would bring about breakages of the rails in work.

Upon the suggestion of the noble Chairman, a hearty vote of thanks was accorded to Mr. Williams for his valuable paper.

An interesting discussion then took place upon the manufacture of iron rails, in which several of the members of the Institute engaged.

Mr. T. J. Smith (Barrow-in-Furness) considered that the Institute had been placed under great obligations, as was the trade generally, to Mr. Williams; and the obligation would be increased if the definition he had been pleased to give of steel rails could be carried into effect. There was a point on which he thought Mr. Williams was misinformed, and that was that in a few months (in February), when the Bessemer royalty would be reduced, rails of that character could be had at 9*l.* per ton. (Laughter.) So far as he had been able to ascertain, rails had been at very nearly that price for a considerable time, and the majority of the steel rail masters were looking forward to the time when the royalty would be reduced, that they might be able to recoup themselves for the expenditure they had had on their works. (Hear, hear.) Mr. Williams also stated that iron rails were capable of standing the wear of a considerable traffic for as many as 15 years; that he did not doubt, because he knew instances in this country where rails had been down that time or longer.

Mr. R. Fothergill, M.P. (Aberdare), asked Mr. Williams, who had attached so much importance to the perfect welding of the rail pile, what in his opinion, constituted perfect welding? (Hear, hear.) Did he consider that welding consisted of the two surfaces being, as it were, glued together by the cinder—the oxide of iron which formed together between them; or did he consider that the metal in itself had a sticking quality without any intermediate material? Did he consider that the two surfaces became incorporated together?

Mr. Walter Williams (Tipton) briefly described the manner in which rails were manufactured on the Continent, especially in Russia. He had seen from a 12-in. pile a rail finished at one heat, the head crystalline and the flange fibrous. If they were able with their common puddled iron to make rails that stood the test that our own iron stood, there must be really something in the first process. The rails were rolled out at the rate of one a minute—(100 revolutions were attained)—with perfect crystalline top and fibrous bottom. The welding must be perfect, or the defect would evince itself in the crystalline top. The iron was similar in quality and character, and if they were able to do it there, it must be possible to do it here.

Mr. Hopkins (Middlesborough), as one practically connected with the manufacture of rails, offered his thanks to Mr. Williams for his eminently practical paper on rail making. He presumed the author, in condemning the system of excessive testing, applied his remarks especially to double-headed rails. If so, he entirely agreed with him. (Applause.) Practically, a lighter test was sufficient to secure a thoroughly good general wearing rail, and a rail that would stand the traffic of any railway. (Applause.) As regarded the rail with wearing head and flange foot, to make a bearing surface on the sleeper, a much heavier test could be applied than in the case of double-headed rails; for in the former the fibres were at the foot of the flange of the rail, a crystalline head being still preserved.

Sir William Armstrong need hardly say that, in the manufacture of guns upon the coil system, a perfect welding was of just as much importance as it was in the manufacture of rails; and great attention had been given, both at Elswick and at Woolwich, to the devising of a test which would indicate with some degree of certainty the fitness of the iron for the purpose of making a perfect weld. The conclusion arrived at eventually was this (and it was arrived at both in their practice at Elswick and at Woolwich) that in proportion as the iron had a steely character, so in proportion it was unfavourable for welding. The indication of its steely character was obtained in this way—they took a specimen of the iron, heated it to a certain point, and then plunged it into water; if they then found its tensile strength was increased beyond a certain limit, it was rejected as unfavourable for welding. That iron welded most perfectly which underwent no increase of strength in the process of hardening. Almost all iron did receive an accession of strength similar to that observed in steel by the process of plunging when hot into cold water, though to a less degree. He had a little difficulty in reconciling what he had just stated with what Mr. Williams had said in reference to the constant re-working of the iron, unless it did assume something of a steely character, which he had some difficulty in understanding. Then there was another point on which he might speak, though with more diffidence, and that was in regard to the mode of testing rails. The test which was ordinarily practised of selecting a particular rail—allowing a heavy weight to fall upon it—might be very well for indicating the general character of the material, but it was not at all a proper method of welding out the rails which were defective in manufacture. He did not see why there should be any difficulty in exposing a rail to a moderate test of that kind. It would not be difficult to devise some apparatus by which that should be done without any manual labour at all. If the rails were laid on a moving machine and struck with a certain force which would not endanger a good rail, but which would as certainly break all rails which were inherently bad, the end would be answered. (Applause.)

Mr. I. L. Bell would scarcely, in a company embracing so many men of more extensive and more recent experience than his own, as that meeting did, have made any observations, except for one or two remarks which had been made. He would, however, take the opportunity of expressing his acknowledgment to Mr. Williams, for his very valuable and able paper, and he would also call the attention of the meeting to the advantage likely to follow from the establishment of an institute like that which brought together gentlemen of experience and large information in the various branches of the iron trade, and all viewing its condition from different points. That impression was awakened in his mind by the remarks of Sir Wm. Armstrong, as to his experience in the treatment of iron, though for a different purpose entirely from that of rail making—namely, that of ordnance. Having alluded to one or two of the remarks of Mr. Smith, he said that having, in the capacity of railway director, had experience in the use of rails, and taking a deep interest in the prosperity of the Cleveland trade, he felt justified in giving them the results of that little experience. It was of the greatest importance that they should satisfy themselves and the public that it was possible from the Cleveland ore to make a durable rail. He felt that the quality of the rails generally had suffered materially from the wish on the part of the buyer to obtain the rail at far below the cost at which it could be produced; and, secondly, harm had been inflicted on the manufacturer by the demand for a species of test utterly unnecessary and excessive. They had on the North-Eastern Railway a great number of rails which had worn uniformly down, until from absolute wear they had become unserviceable. It became a most interesting question to him to know what was the character of that iron which had been better able to stand the wear and tear of the railway than iron which appeared to be of a much better quality. He subjected it to an analysis, conducted by Mr. Marreco, a very competent person, who discovered not in one instance only, but in many, that the rails were distinguished by the excessive amount of phosophorous they contained, and, in point of fact, was precisely due to that quality, in which, probably, Cleveland stood pre-eminent. (Laughter and applause.)

Mr. T. W. Plum (Old Park Ironworks, Shropshire) thought it worth investigation whether a homogeneous rail from the solid bloom might not be made very nearly approaching in durability and quality to some of the steel rails. The days of steel rails were coming very fast upon them, and it might be worth while for the iron rail makers to turn their attention to the subject. As regarded welding, he might say that he had had some experience in working iron for guns at Woolwich, and some time after that he had to start a tire-mill on the coil principle, similar to that adopted in the construction of guns, except that the bars for the welding were flat instead of square, as used for guns. He encountered some difficulty in getting the coils to weld properly, and after some little experience he had them made with convex sides; and so superior was the results obtained by the use of convex bars that, having on some occasions had Swedish iron which was difficult to weld made into tires, the result was perfectly satisfactory. It was desirable to consider whether rails could not be made from solid blooms, instead of piles as hitherto.

Mr. Head spoke in reference to Mr. Williams's opinion on the nature of welding, and asked whether he thought it a process of sticking or gluing two pieces of iron together, or whether the two metals were consolidated into one. He thought all who had had much experience in welding well knew that the smiths threw a little sand upon the two pieces of iron, and he believed there were some very pure qualities of metal which would hardly weld without the sand. That seemed to prove that it was the cinder which actually formed a sort of glue to stick, as it were, the two pieces together. The previous speaker had referred to Swedish iron, a very pure metal, but which was welded with difficulty. He presumed that would be held rather to confirm his view of the question. Some elaborate experiments had been made by the Government with the view of testing how much chain-cables were inferior in tensile strength to the iron from which they were made, and the bars so welded (when properly welded) were found to have above 90 per cent. of the strength of the solid iron. Welding, therefore, properly done, must be considered almost as strong as solid iron.

Mr. Williams then replied to the several speakers. It was most comforting to hear from Mr. Smith that there was no probability of the price of ingot rails coming down to 9*l.* per ton, but it would take some persuading to bring him to believe that they would not go lower, and it was manifestly all the better for people who were pursuing the business which they were told was in process of being civilised off the face of the earth—(laughter)—to know that the difference between ingot rails and the cost of their iron rails would be more, rather than less. (Hear, hear, and laughter.) With a difference as between 6*l.* 10s. and 9*l.* they would be able to hold their own and live—(applause)—and if the price of steel rails were higher than 9*l.* they would, of course, have all the better chance. Of this, however, he was convinced, that they could make very good rails from the iron of that district. There were some at least who intended to try (applause)—and if they did not succeed they would not die without an effort. (Laughter.) They had some capital leaders, foremost amongst whom was Mr. Bell. (Loud applause.) The probable price of rails, then, being 8*l.*, he could not agree with Mr. Smith in expecting anything of the kind. The sellers of rails, of whom Mr. Fothergill was one of the chief in his district (South Wales), would bear him out in saying that 8*l.* per ton was very much higher than the average price over a series of years; he would not be surprised to find 6*l.* 10s. higher than the actual fact. Mr. Fothergill had asked a question which it was exceedingly difficult to answer. He had asked it often himself, and had thought many a time that he had come to understand it, as he had done other things which he afterwards found he knew nothing about. (Laughter.) He could not say what welding was. He had seen a little of it—(laughter)—and perhaps he ought to know in what it consisted, but he really did not. He could only give a rough notion of what he thought it was. Good welding, he believed to be a combination of effects; the actual amalgamation of the two parts of the iron, and actual contact and soldering together by means of the cinder. In proportion as they had more of absolute contact and less of the solder, by so much was the welding good or bad. Where there was no contact of the actual metalic surfaces, and nothing but the soldering of the layers together by means of the cinder, they had poor welding, and it was the poorer the thicker the solder; whereas, on the other hand, the larger the proportion of one surface actually brought into contact with the other the better the welding. (Applause.) So far as he knew, perfect welding—that was, complete contact or anything at all approaching it—was utterly and entirely impossible, except by melting, or something very close to it. No doubt the wrought-iron of that district did weld very well, and he had been trying to account for it. The reason, he thought, must be this—that the thin layer of cinder that was always upon the face of the bars of iron was, when produced from the iron of that district, so exceedingly fluid that it ran away and became very thin, and therefore admitted a greater proportion of the surfaces to come into actual contact one with the other. (Applause.) Those were the best explanations he could give. With regard to Mr. Walter Williams's observations, he might say that he had seen the manipulation of the large piles on the Continent, and he arrived—not at the conclusion Mr. Williams had arrived at, namely, that they made good rails and a good job, but exactly the reverse. (Laughter and applause.) He did not think it possible by any ordinary furnace, and by any ordinary skill, to heat a pile of 12 or 13 in. at the centre without over-heating some other portion of it, and so make the perfect weld there ought to be. Again, 100 revolutions per minute was no extraordinary speed, nor was the making of rails at the rate of one a minute extraordinary work. Much had been said about the superiority of foreign rails and ironworkers. He had been at the trouble to visit the great iron works on the Continent with a view of ascertaining the facts, and he went with as unbiassed a mind as it was possible; certainly not with any desire to prove a case on his own side; and he was bound to say that he had seen nothing in the wrought-iron operations on the Continent, except a few girders, which were simply considered an achievement, that was superior, or indeed, on the whole, equal to the iron manufacture of this country. (Applause.) He was firmly of opinion that whether they considered the men who were the leaders of the ironworkers, the machinery used in the making, or the skill of the ironworkers themselves, they need not have any fear or any shame in being strictly compared with the machinery and the men of the Continent. (Applause.) In answer to Mr. Hopkins, he admitted that his own remarks did not apply so much to flange rails as to double-headed rails. It was no doubt possible to make a very crystalline head and a very fibrous flange, but even in that case the difficulty of welding was much increased. For successful rail making it was necessary to have a great heat on both edges of the bar; if not, a different degree of elongation would be produced, and the bars would come out twisted in all directions. They would have a better chance of making a thoroughly good rail when they had similar quality of iron all through, instead of having crystalline heads alone. In alluding to Sir William Armstrong's observations, he said he presumed that in welding the coils together a very high degree of heat was necessary, and he should like to know whether when a welded coil was broken, after the welding, the iron was always found to be of a very crystalline character. Unless he was altogether wrong in his opinion as to fibrous iron, it was extremely difficult to weld at any heat whatever; a very high heat always converted fibrous iron into crystalline iron. The idea of testing each rail by a self-acting apparatus was very ingenious and appeared practicable. He was not sure, however, that the blows necessary to try each rail would not go a very long way towards spoiling it. If the rail were tested to the extent that was really necessary, and not to the extent required by the purchaser, it might be done without damage to the rail. It was a question, however, whether the buyer would be content. Again, the blows must not damage the surface of the rail, otherwise a starting point would be afforded for the wearing of the rail. Mr. Plum hoped they would still be able to make rails from solid puddle blooms. He himself did not, and he did not think that any amount of hammering could give them what they wanted. The puddle ball was simply a sponge, and the larger it was the larger the cavities in it would be. These cavaties were full of cinder when the ball came under the hammer. In the process of hammering the outside was so closed up that the cinders from the inside could find no escape. Hammering, then, to any extent would simply flatten the cavities without at all expelling the cinder; and he did not see how, under such a state of things, they could ever have a solid rail. Mr. Head had suggested the employment of sand, but he had tried that many times, and had not been able at all to succeed. He thought it would be impossible so to regulate the quantity as to make sand available. The irregularity and uncertainty in putting on the sand would tend to greater evils than those which they were endeavouring to avoid.

[*To be continued in next week's Journal.*]

Original Correspondence.

COLLIERY WORKINGS—FOWLER'S CLIP DRUM.

Sir,—In reply to "Enquirer," I think that he will have no difficulty in seeing the application of the drum to the purpose he requires; but for full information I would refer him to Messrs. Fowler, or their agent for this district, Mr. George Cockburn, Collingwood-street, Newcastle-on-Tyne. "Enquirer" will, I have no doubt, contemplate using a wire-rope in driving the pump. M. E.

[We have reason to believe that we shall receive, from Messrs. Fowler and Co., full descriptive particulars of their Clip Drum and Pulley, and its application—which we shall be glad to publish, as being of much interest to our readers.]

COLLIERY WORKING—FOWLER'S CLIP PULLEY.

Sir,—I observe in the Journal of Sept. 18 that one of your correspondents, "S. B.," wishes to be supplied with certain information as to the power to be obtained from a clip pulley when placed in a certain position. And also in last week's Journal another correspondent wishes to know where he can see working a double-acting pump driven by a clip pulley 1000 yards from the engine, and raising water a certain height. Now, if either of your correspondents will favour me with their address I shall be glad to introduce them to certain mining engineers in the North of England who are working them daily in the positions they name. Geo. Cockburn.

25, *Collingwood-street, Newcastle-on-Tyne, Sept.* 29.

COAL-CUTTING MACHINERY.

Sir,—As this subject is again before the public, I beg to ask through the Journal, such of your correspondents that saw the first machine at work at the colliery belonging to Messrs. Firth and Donisthorpe, in 1862, if it was in principle like the one now advertised in your columns called "Compressed Air Coal-Cutting Machine, Firth's patent?" I did not see the first one, neither am I at present interested, but in all probability should be if this difficult point could be explained without the dread of a Chancery suit, so that one could see the road clear. The question is at present rather complicated, which I consider is one great reason why they are not more adopted; and if Mr. Rothery's statement is not exaggerated, he has, in my opinion, reasonable grounds for questioning Mr. Firth's claim. A descriptive reply, given by some disinterested mining engineer through the Journal, would possibly be sufficiently effective to the public as a decision in Court, which, under the most favourable circumstances, almost makes one shudder. Enquirer.

Birmingham, Sept. 29.

COAL-CUTTING MACHINERY.

Sir,—Your correspondent, signing himself "Collier," in last week's Journal, makes some not very logical remarks upon this subject. While he admits that the "pick machine does not do such very bad work whilst it is at work," he goes on to state "that it is so frequently out of order," and that its speed is such, that in a couple of months it will not do more work than would be done by the same number of men without it; that the coal cut by it is more damaged than when cut by manual labour; and that although it may cost the coalmaster less it will not leave him as much profit. If these statements had not found their way into the *Mining Journal* nobody would stop to answer them, but since they are there a very short reply seems desirable, in the interest of an important invention, and the cause of truth.

There is a pick machine at work which, during the last 12 months, has cut upwards of 30,000 tons of coal, and has not been "out of order" for three whole days during that time. It is worked by two men, and contributes one-third of the expense of an engineman's wages. Anybody can make the calculation as to the *speed* of this machine. The coal is less broken than the coal got by hand labour, and commands a higher average price in the market than the same seam yields at any other colliery. I enclose my card, and if your correspondent desires to really understand the subject about which he has written to you, he can do so. A Coal Owner.

Sept. 28.

COLLIERY WORKINGS—FIRE-DAMP EXPLOSIONS.

Sir,—Please afford me space in your next number for the enclosed, as supplemental to my letter in the *Mining Journal* of June 19, with two or three former letters upon the same subject,—probably to be read for the moment, as it were, and no more thought of, and as though the loss of the lives of 200, 300, or 400 men at a time was not worth their further notice, nor as yet are any right steps to stop such accidents attempted; likewise my correspondence with Mr. Secretary Bruce; also many private letters I have written to various coalmasters, and to companies when and where explosions have occurred, offering to restore their works to healthy operations, and to countermine fire-damp—no cure no pay—that is, Risca, Hartley, Barnsley, Talk-o'-th'-Hill, Wigan, Haydock, Tredegar, Ferndale, and Abersychan. All such terrible losses of life have hitherto passed over as accidental, but henceforward it must be otherwise.

In the *Mining Journal* of Sept. 25 some party feels annoyed at Mr. Sandford, Government Inspector, for imputing the fearful explosion at Homer Hill to the ignorance of those in charge of the mine. I am an entire stranger to both Mr. Sandford and to the party thus annoyed. All are open to read my correspondence with Mr. Secretary Bruce, as to my avowed capabilities to countermine fire-damp explosions, so as to ensure the use of the naked candle, or any other lights, to burn with impunity throughout the entire workings; and all parties are at liberty to read it and judge for themselves.

135, *Long Acre, W.C., Sept* 29. Joseph George.

"The recent appalling losses of life, and bereavements, connected with mining operations will, I trust, be accepted as a sufficient apology for my presuming to address you on the subject. Hitherto no certain and effectual remedy has been discovered to protect miners from the destructive effects of fire-damp, notwithstanding much consideration has been devoted to the subject by men of high scientific attainments; and it has at length become a question of deep and general interest whether the Government might not, with great advantage, devote its renewed attention to the removal or abatement of this growing evil. I was born 1795, and have been a practical mining manager all my life, the result of which is, I have real capabilities to countermine it. I have discovered a system of working by which these terrible accidents may be prevented with certainty. The immediate purpose of this note is respectfully to request the honour of a short interview with you, that I may, in confidence, submit my invention to your inspection, and should you approve it, I venture to hope you will favour me with a few suggestions as to the best and promptest mode of promoting the adoption of my discovery. It is a matter which is closely related to the specific duties of your important official position; and should my invention, through your counsel and sanction, be brought into general operation, it will, I feel assured, be a great satisfaction to you to know that you have been instrumental in giving effect to one of the greatest material and social ameliorations of industrial life."

IRONWORKS, AND COAL MINING IN SOUTH WALES.

Sir,—At the recent meeting of the Iron and Steel Institute, at Middlesborough, the economy of iron manufacture was the subject of some discussion. Mr. Edward Williams states, from an extensive acquaintance with the iron manufacture of the Continent, that he had seen nothing to equal this country, either in respect of those directing the works, the skill of the workmen, the machinery, or the quality of the productions. A contrary opinion has lately been expressed by a South Wales ironmaster, asserting that in this country we are far behind the French and Belgian ironmasters in appliances for the smelting and manufacture of iron. This will be a question for those to decide who have seen the process of manufacture carried out, both in this country and on the Continent. It is well known that manufactured iron is sent from Belgium to this country at a price lower than it can be produced here at our own works. Does this arise chiefly from the lower rate of wages paid to the Belgian workmen, or is it due in any degree to mechanical improvements in smelting, or to greater skill and economy in conducting the different processes in making finished iron? But though South Wales is important as an iron-making district, there are some in advance of it. Some of the processes connected with iron-making in South Wales seem very antiquated, and attended with waste of material. The manufacture of coke in open clamps is an instance of this kind; the calcining of the ironstone is another, and the neglect in not utilising the gases from the blast-furnaces and puddling-furnaces.

The Cleveland District.—These matters are much more closely attended to here, as the cost of coke at the furnaces is 11s. per ton and upwards, and coal is costly in proportion. For economising the use of coke in the blast-furnaces their height has been increased from time to time, from 45 ft. to 95 ft. and upwards. Several of the original 45-ft. furnaces are still standing in the neighbourhood of Middlesborough, but disused. It has been found at the five furnaces of Messrs. Bolckow and Vaughan that the furnaces of 95 ft. high and 16 ft. bosh are a little more economical as to the use of coke than the other three furnaces of the same height; two of them are 23 ft., and the other 22 ft. in the bosh; the capacity of the latter is about 20,000 cubic feet, and of the former about 10,000 ft. The production of pig-iron will not be in the same ratio, but is greatly augmented in the larger capacity. Another question of economy is the heat of the blast. It appears that with the blast heated to 1300° in high furnaces, 22 cwts. of coke are required in reducing 1 ton of pig-iron, and 1 cwt. of coke is saved for every 100° increase of blast, from 650° to 1150° and upwards. As the blast is heated invariably with the waste gases of the blast-furnace, this saving represents a direct economy in fuel. The blast-furnaces in the Cleveland district are closed at the top with bells, with the exception of the furnaces at Grosmont, the gases from which are withdrawn by means of chimney draught. At the furnaces of Messrs. Bolckow and Vaughan calcining kilns, 45 ft. high, 21 ft. in diameter, are erected of 18 inch firebricks, covered with ½-in. plates. The yield of iron from raw ore is about 30 per cent. One ton of coal will calcine about 40 tons of ironstone in these kilns; the calcined stone is let out from the bottom of the kilns direct into barrows. The coke is deposited in hoppers, and is let out at the bottom into barrows by sluices, and afterwards raised to the top of the furnaces. The mode of raising materials from the ground to the top of the furnaces in most cases is by water-balance, the supply water being pumped into a tank by a steam-engine. Two works have hydraulic hoisting-apparatus, some by pneumatic pressure, and others by direct steam-power.

The Plymouth Iron Works.—On a recent visit to these works I was offered every facility for inspecting the operations, and the collieries in connection with them. My account dates from the year 1765, when Mr. Bacon purchased the single blast-furnace then erected. The property a few years afterwards came into the possession of the Hill family, by whom the works were greatly extended, and continued in their possession until the death of Mr. Anthony Hill, in 1852, who was the last survivor of three brothers. The works were then purchased by Messrs. R. Fothergill and T. A. Hankey, for the sum of 250,000*l.* During the time the works were under the management of Mr. A. Hill his great practical experience was brought out in producing pig and finished iron of the best quality, which made Plymouth iron a name over the world for its tensile strength. Though Mr. Hill was supposed to be in possession of secrets in iron-making known only to himself, and which would die with him, yet the quality of iron at these works, we are assured, is maintained at the present day, and is due to the selection of the best ironstones for use in the blast-furnaces, and coke made from the 4-ft. and other seams of the steam coal series. These materials are reduced with cold-blast only in the furnace. Mr. Hill, no doubt, derived great profit from these works, but quality seems to have been carefully studied as well as quantity, and this is the ruling principle of the present proprietors. Cable iron is extensively produced. The chain cable works carried on by Messrs. Brown, Lennox, and Co., at Newbridge, are supplied from Plymouth; the cable bolts for the Great Eastern were made here, from Welsh mine and coke produced at the works.

Plan of the Works.—The works are on the property of Lord Plymouth, and situated between Merthyr and Troedrhiw; they are built in three divisions—Plymouth furnaces at the upper end, Pentrebach in the middle (where the forges and mills are established), and Duffryn furnaces at the lower or southern end; these divisions are about one mile asunder. The principal feature in the plan of these works seems to be their adaptation to water-power. There are two large water-wheels which furnish the supply of cold-blast to the Plymouth furnaces; the water from these is utilised again at the two water-wheels at Pentrebach, and from these to two more at the Duffryn

furnaces. This seems an economical arrangement, but in dry seasons a scarcity of supply is felt, for which provision is made. Another feature is the situation of the pits with respect to the coke yards and mine kilns; the top of the coal pits are on a level with the coke yards, and the mine pits are also suitably placed for the kilns. There are six locomotives (running on the 2 ft. 8 in. gauge) at the high level, conveying materials between the pits and the iron works. On the lower level, at the bottom of the furnaces, there are six locomotive tank engines, on the 4 ft. 8½ in. gauge, used in conveying materials to and from the Taff Vale Railway siding, near the Duffryn works, also coal to the forges and mills, and materials from the other divisions of the works. This line of rails has a connection, also, with the Vale of Neath Railway.

PLYMOUTH FURNACES.—There are five blast-furnaces, three of them now in operation. The height, including the Duffryn furnaces, ranges from 40 to 50 ft.; 16 ft. in the bosh is the greatest diameter. The production of pig-iron in each varies from 90 to 110 tons per week, according to the quality required. Welsh mine and hematite ore is used. The mine is calcined in kilns, placed immediately behind the top of the furnaces. The coal is coked in open clamps, situated behind the kilns. Some coke is made in ovens, from a seam of bituminous coal; these are situated a considerable distance below Duffryn. The blast is supplied to the Plymouth furnaces by two large water-wheels, working four 66-in. blowing cylinders, and one 90-in. cylinder. There is no blast "regulator;" the blast is equalised by the number and size of the blast-pipes. The gases from the furnaces are not utilised here.

PENTREBACH WORKS.—There are established here 74 puddling-furnaces, four forges, and seven rolling-mills. For the forges there is one water-wheel, 20 feet in diameter, about 16 feet wide; one pair 22-in. engines, as auxiliary to the water-wheel when water is short in supply. One 27-in. forge-engine direct to rolls. One 60-in. engine, 8-ft. stroke, drives two pairs of forge-rolls and two bar-mills. There are three steam-hammers at work for beating puddle-balls, one of these (Condie's patent) 6½ tons weight, and 7-ft. fall; one squeezer. Two more hammers are in course of erection. About 850 tons of finished iron is produced weekly from seven mills; for the manipulation of this iron there are one water-wheel, 27 feet diameter, driving-rail, and bar-mill; on pair 20-in. auxiliary engines, when water is short to supply the wheel; one 16-in. engine, driving one slitting-mill; one 18-in engine, 2-ft. stroke, driving bar-mill; one oscillating-engine, 23-in. cylinder, drives two small bar-mills. Besides these there are several small engines for driving saws, presses, punches, and shears, each, as a rule, having an independent motive-power.

DUFFRYN WORKS.—There are five blast-furnaces erected, four of them in operation, and two refineries; these are supplied with cold-blast by two water-wheels. Two of the furnaces are adapted for utilising the gas for the boilers. The arrangement of the mine kilns and coke yard is the same as at Plymouth furnaces.

COLLIERIES IN CONNECTION WITH PLYMOUTH IRON WORKS.—The area of coal leased has been greatly increased since the present proprietors purchased the works. About 1300 tons per day is the average output of coal, obtained from the 4-ft. smokeless steam coal seam, and from other seams yielding a similar quality of coal; about 400 tons of this is shipped at Cardiff and Swansea, the remainder being used at the works. There are five pits from which coal is raised and two levels:—

1. LEVEL ON THE CASTELL WIWR SEAM, 2 ft. 6 in. thick, used in the forges: this is up the hill a great height; at present the coal is got from the dip; a hauling-engine at the mouth draws the trams of coal up from the dip to the mouth; these are lowered by self-acting inclines to the works on the high level. About 200 tons per day worked.

2. THE SOUTH DUFFRYN PITS.—There are three pits here—the pumping-pit, 15 ft. by 10 ft., sunk 260 yards to the lowest, or Gelly-deg seam. The pumping-engine is Cornish, 85-in. cylinder, 11-ft. stroke, 9-ft. at the pit end of the beam, condensing, 25 lbs. pressure, four boilers, three Cornish and one plain. This engine pumps from the 9 feet seam, at the depth of 207 yards. There are three forcing sets, all 21-in. rams; it goes day and night; in the wet season it goes up to 7½ strokes per minute; in the dry season the water diminishes, showing that the supply originates in some degree from the outcrop of the seams, and filters down to the lower workings. A 10-in. vertical beam-engine, 2½-ft. stroke, was used at this pit first, and afterwards at the Velocity Pit for sinking, it is now used for lowering or raising men in the pumping-pit. The Velocity Pit is 15 ft. by 10 ft. in section, 30 yards north of the pumping-pit, and 207 yards to the 9 feet seam. The winding-engine has two 30-in. horizontal cylinders, 5-ft. stroke, direct action, double-seat valves, 14-ft. plain drum, round wire-ropes. There are five plain high-pressure boilers. About 350 tons per day raised from the 4 ft. and 9 ft. seams, principally 4 ft. One tram holding 1 ton of coal, raised in each carriage; the carriages run on three wood guides. The 9 feet coal is got from a level running eastward from the pit, about 800 yards to the face of it. The coal averages 7½ ft. thick, with a band of shale in it; it is worked exclusively on the stall and pillar system; the double stalls are 12 yards, and the pillars 12 yards wide; it produces fire-damp more freely than the other seams worked in this pit; lamps are used; no blasting is allowed; about 20,000 cubic feet of air circulates through this part of the mine. From the 9 ft. seam a stone drift, across the measures, commences near the pit; it is driven south, 700 yards long, to the 4 feet seam, with a slight rise. The 6 feet seam is intersected in the drift; the thickness of coal is usually 3 ft. 4 in.; here it is less, and the heading is being driven to prove it further. At the end of the stone drift a dip to the south is being driven in the 4 feet seam. A spring of water was lately got from the roof, to which the mine is much subject; it is 200 yards down; this is pumped by a hydraulic-engine, fixed at the end of the drift; this engine has four cylinders, two rams; each ram works in two cylinders placed in line; connecting-rods are fixed to the rams; the rams are 10 in. diameter, 2½-ft. stroke; cog-wheels 4 to 1; one drum, which is designed to haul coal up the dip. At present the engine pumps water from the spring, 200 yards down, with 10-in. forcing-pump; the motion is communicated from the engine by a bell crank, and wood rods running on rollers down to the pump. The head of water available for the engine is 67 yards, brought down in the 4 ft. seam in 9-in. pipes; the pressure of water at the engine is found to be 65 lbs. per square inch. The water that is utilised by this engine would otherwise flow to the bottom of the pumps without any service. The level to the east, in the 4 ft. seam, is about 1200 yards in from the stone drift; three cross headings are in operation at the extremity; the level is driven 3 yards wide; an air-way alongside, 3 yards also, 18 yards of pillar between. The cross headings driven to the rise or north, rise about 3 inches per yard, 16 yards wide, two roads, and filled up with debris between them; the double stalls are turned out of these, on each side, east and west, 12 yards wide; 12-yard pillars; the stalls are commenced 3 yards wide, and gradually widened until they meet; the space between the roads is filled with the refuse of the seam. Section of the 4 feet seam:—

Strong cliff roof.			Clod	0 ft.	4 in.
Top coal	1 ft.	4 in.	Bottom coal	2	4
Clod	0	10	Clod (holing)	0	4=7 ft. 6 in.
Good coal	2	4	Hard underclay.		

The holing is made in the bottom clod, and the coal brought down by wedging and bars. The pillars are worked back on the completion of the stalls and stowed, but not to the same extent. Cross-headings are made 120 yards apart, a division of air given to each cross-heading, or sometimes to two, when the length is short. The seam does not produce sufficient material for filling up for the long wall method, unless further material were raised from the bottom. Coal of larger size would be produced to compensate for this additional cost in labour. The 4 ft. seam does not produce much fire-damp; lamps are used; no blasting is required. A dip cross-heading is at work further back from the rise-headings. About 30,000 cubic feet of air circulates in this seam. There are 39 horses in the pit. The trams are open-bodied, with 16-in. flange-wheels, running on 25-lbs. T-head rails; gauge, 2 ft. 8 in.; bridge-rails in the stalls 18 lbs. per yard. One horse draws from five to eight trams on different sections of the road. The roads have been changed from the old-fashioned tram-plates to the rails and flange-wheels since the present owners took possession of the collieries. This change, as an economical reform, will no doubt be satisfactory. The Balance pit, about 12 yards north of Velocity pit, is 16 by 10 ft., 140 yards depth to 4 ft. seam. Coal is raised by water-balance from the Yard and 4 ft. seams to the extent of 140 tons per day. The Yard seam is worked by long wall.

3. THE NORTH DUFFRYN PITS.—One pit 114 yards depth to 4 ft. seam not in operation, one pit, 160 yards depth to 9 ft. seam, is used solely as an upcast for South Duffryn Mines and Taibach in part. One pair of 20-in. winding-engines, 4½-ft. stroke, standing here; also one pair of 16-in. cylinders, 18-in. stroke.

4. TAIBACH PIT.—One pit 160 deep to 9 ft. seam; coal raised from the 4 ft., 6 ft., red coal, and 9 ft. seams. About 250 tons are raised per day. One pair of 14-in. winding-engines, 18-in. stroke, are in operation.

5. GRAIG PIT.—One pit 114 yards deep to 6 ft. seam; stone drift to 4 ft.; 150 tons per day raised. The upcast for this mine is north of the pit, and serves for Taibach Mine in part. One 60-in. Cornish pumping-engine, 9-ft. stroke, in operation; also one pair of 18-inch winding-engines, 2-ft. stroke.

6. ABERCANAID PIT.—80 yards depth to 9 ft. seam; coal raised from the Yard, 4 ft., 6 ft., and 9 ft. seams. About 250 tons per day may be got. One 24-in. engine winds coal and pumps at night.

7. GELLY-DEG SEAM.—The lowest coal, 50 yards under the 9 ft., is got by level; 150 tons per day.

MINE WORKINGS.—There are four pits where mine is raised, one of these is at Penydarren, from 800 to 1000 tons got weekly, from the blue veins and fine pins. The principal veins of mine lie above and below the Gelly-deg seam.

1. ORIGINAL PIT.—One 24-in. pumping-engine, 4-ft. stroke, in operation; also one pair of 18-in. winding-engines, 2-ft. stroke.

2. ELLIS PIT.—One 12-in. winding-engine, 2-ft. stroke.

TREHEDDA.—One clay mill, with engine and boiler for grinding the fire-clay.

The PENYDARREN IRON WORKS have been purchased by Messrs. Fothergill and Hankey; they consist of seven blast-furnaces, four refineries, and forges and mills; these at present are all dormant. There is some mineral property attached to these works.

MEANS FOR EDUCATION.—The employers at the Plymouth Works provide ample means of education for the children of their workmen; two sets of National Schools, near the Pentrebach Mills, were built by Mr. Hill, and purchased with the works; one of the schools has been enlarged, and made suitable for performing church service. There are National as well as British Schools at Troedrhiw; in Abercanaid district, too, there are flourishing schools: towards most of these Mr. Fothergill contributes liberally. No stoppage is made from the workmen's wages on account of education, unless it is their own request to do so. On the whole, the children have sufficient opportunities for education, and we hope that whilst these are receiving a training to fit them for the duties of life, the adult class will not be forgotten, that libraries and reading rooms will be instituted for them, which, when they are able to read with ease, would open out new sources of enjoyment, and contribute greatly in raising their social position.—*Sept.* 28. ——— M. B. GARDNER.

THE SOUTH STAFFORDSHIRE AND SHROPSHIRE COAL FIELDS—No. XVII.

SIR,—It is not surprising if those unacquainted with the jargon of the mine should be staggered on hearing for the first time of the Symon Fault: it is a term which conveys but little meaning, even to those tolerably well up in such technical phraseology; whilst no one whom we have met with seems to know anything of its origin, excepting that Symon, or Symony, locally signifies something faulty or deficient. And there are few, even amongst those familiar with the phenomenon the term is supposed to represent, who can bring their minds to believe in the extent of the gap in the coal measures of which the Symon is understood to be a first indication. I purpose, therefore, in this letter, with your permission, to clear the way for a better understanding, to recapitulate just sufficient to place the matter in a better light, and then to challenge those who either ignore the existence of the fault or underrate its importance to declare their views, and to show grounds for holding them. To be explicit, permit me to state that I use the word *denude* in its broad and popular acceptation—to strip or divest and lay bare something previously clothed with the thing removed, a process an illustration of which is to be found on the present surface, that being but the modelled outline denudation has given it; thus, every valley, plain, or bit of ground, whether soft or hard, may be considered to be the result of displacement by one or other of those agencies which have been in operation from the beginning until now—as rivers, currents, and waves of the sea. Their action may be slow, yet it requires little faith to believe that it is by them that mountains are removed and cast into the sea; and there is no reason that we know of why such agencies should formerly have been more potent, why they should have acted with greater intensity, or why they should have occupied a lesser period in accomplishing their task than at present. We see the atmosphere at work on the hills, reducing the hardest rocks; we see rivers deepening their channels, and often widening the valleys through which they flow; and we find everywhere in the present outline of the country evidence of their operations. The Severn and the Wye flow through valleys very much of their own creation; on their banks are beds of coal and ironstone, one above another, which everyone knows did not originally terminate at their present outcrop, the upper one terminating first, the second advancing further into the valley, and the lowest farther still; whilst a line drawn from the point where the upper one terminates to that at which the lowest ceases, gives the slope at which the material found a rest—as on a railway embankment, where the angle is less or greater as the ground is hard or soft. Follow the Severn to its estuary, and the same thing occurs, only that the coal measures lie hidden in the hollow of the Bristol Channel: or take some modern coast line, where streams have for ages been finding their way to the sea, and you discover easy, uniform slopes, like those leading down to the Cardigan and Aberystwith Bays, or that at Borth, where the sea having scooped out an estuary has left it to be filled up with drift, and sand, and peat. Here, within a recent period, there has, therefore, been a sinking of land, to allow of the encroachment of the sea, and then an elevation to throw it off. You will also find inland vales which evidently once were bays, vales whose sides once were shores, and terraces which were formerly sea beaches, all the effects of aqueous excavations, carried on through long periods of time. The virgin sod, enamelled now with flowers, hides many an ancient scar, and covers a surface on which the fiercest forces have each played a part. Nature has planed down inequalities, smoothed over and adorned the surface where rents 1000 feet deep exist; and it is only the miner, who dives beneath, who is brought face to face with these old scars, rents, and fissures which water and fire have made; he has to map them, to calculate their difference of level, and to modify his working plans accordingly.

At Brosely, about 200 feet above the Severn, the workmen found an old bed of that or some other river between the coals, the latter being soft, weathered, and waterworn; then came a bed of sand and gravel, beyond which the coals came in again, in the same way as they had disappeared. In the Forest of Dean river channels through the mines have been found, with rounded pebbles of coal, older than the underlying and undisturbed coal measures. Similar instances occur in the Newcastle and Durham coal fields, where a bed of sand or drift is traced for a considerable distance 90 feet below the level of the Wear, without any trace of shells along any portion of its course, but with beds of shale on the edge of the eastern side, containing the usual ferns and coal plants; coal and stones also are found rounded by the abrading influence of the water.

A case occurs at Moxley, between Bilston and Wednesbury, of an excavation in the coal measures ¼ mile in length, and from 50 to 100 feet in depth, where, north of Wednesbury, the New Mine coal crops into loose sand, which fills up the hollow. During the visit of the members of the Midland Institute to the Shropshire coal field this fault was quoted by Messrs. Beckett and Bromley to show that the coals might come in again in the same way beyond the Symon Fault in Shropshire: a kind of logic equal to that which accounted for the Goodwin Sands by the erection of Tenterden Steeple! There is no analogy in the two cases, as both faults were formed, probably, by different means, certainly at different times; and if it is true, as reported, that a stag's antlers have been found 50 feet below the surface in the drift, a very recent geological period must be assigned it. Still, this furnishes not a bad illustration of the fault of denudation in the Shropshire coal field, if the reader will only suppose the land to be depressed 2000 feet or more, and the sea in the course of ages to spread over drift and coal together 1000 feet of strata, the whole then to be elevated and made dry land, afterwards shafts to be sunk in search of coal: in which case the New Mine coal, the first met with, would be worked, till suddenly it would crop out in this sand bed. But if, instead of sinking down upon the coal beds, a shaft were to be sunk over the basin where each coal bed terminated in the same way, it is evident that the shaft, if carried deep enough, would miss the coal measures altogether, and come down upon the barren foundation rocks, from which they had been taken away. This is precisely what I wish to guard the public against. Shafts have been sunk at an enormous cost into this old valley of denudation which have missed the coals altogether, others upon the edge where the seam began to disappear, others where the first, the second, and third coals were gone; in which latter case the workmen followed the lower coal till it terminated, like the last and lowest of a tier of seats in an ampitheatre.

Let us next examine the edges of the coals where they disappear. It may be but poor satisfaction when the steed is stolen, or the house rifled of a portion of its contents, to examine the lock, and to discourse on the nature of the tool by which the thief accomplished his purpose; still it is important here, as it may assist us in arriving at some conclusion as to the nature and extent of the denuding agent. If we examine the edges of the coals, we find them cracked, split open, and the interstices filled up with silt, sand, or clay. If we follow these lines of denudation south we find the Silurian rocks on which they rested laid bare, and every vestige of the old coal measures gone. In some places it is a mile from the point where the first coal terminates to where the lower one disappears; in others the lower coal extends much farther, showing that the shore became less precipitous towards the bottom; its course to the south, too, is a wide sweeping curve, such as a large body of water may be supposed to leave. It generally happens that where the destruction of strata has been most complete the least evidences of destruction remain; it frequently happens, too, that the most interesting features connected with these rich mineral fields are those which it is most difficult to point out so as to be understood by the general reader, although they are those which, when fully comprehended, show the value of combining the results of scientific teaching with those of practised experience in mining. And it is only by casting about, by meeting with a relic here and there, by reconstructing old lines which now do not meet, and by replacing missing strata, that the geologist arrives at an estimate of the extent of the ravages committed by denudation.

As I have said before, there can be very little doubt of the Shropshire and South Staffordshire coal fields having been formed in one great basin at one and the same time, or that Nature having first munificently raised this great storehouse of mineral fuel again laid it in ruins, leaving portions only to be of use in after ages. It may be very difficult to reconstruct the former state of the surface from the fissures and faults, upheavals and depressions, so as to show how it came about that these coal measures were opposed as barriers to a body of water sufficient to reduce them, also to say whether such waters were thrown against them from the ocean, or whether they were on their way from some high and newly formed watershed to a sea level some distance off: but one thing is quite certain—that at the close of the coal measure formation vast changes of level were effected by powerful upheavings of strata, that elevation and submersion took place, that great bodies of water were dislodged from the ocean, that new water-sheds were formed, and that denuding agencies began taking down strata which the former building up processes of the world had raised.

One thing which makes it clear to my mind that the 800 or 1000 ft. of strata denuded does not represent the entire depth of the valley of denudation is the fact that the water not merely cut down the coal measures, but removed them clear away, which seems to have required an expenditure of force with a downward tendency, towards some terminal point not now visible, even on the border of the coal field. It is opposed, therefore, to every rational process of deduction, and calculated only in the highest degree to lead people astray, to hold up such a will-o'-the-wisp as the supposition that the effects of denudation along the eastern side of the Shropshire coal field are only local, or to hold out hopes, either by statements or sections, like those in the Wolverhampton Exhibition, that the measures will be found continuous, with slight interruptions, between the two coal fields.

Madeley, Salop, Sept. 27. ——— J. RANDALL, F.G.S.

THE PATENT LAWS, AND MR. MACFIE, M.P.

SIR,—Patent law abolitionists have a most unfortunate advocate in Mr. Macfie, M.P. for Leith. If all that is most favourable that can be brought forward in support of the "abolition of patents" is to be found in his book under that title, he and his supporters have little ground indeed for public sympathy. There is something truly whimsical in his treatment of such an important subject—one affecting thousands of inventors, and tens of thousands of manufacturers and traders. He makes a strong point of "simultaneous invention," so strong, indeed, that one might suppose he would exercise his utmost energies to make clear what he means, and give irrefragable evidence of the truthfulness of his position by suitable evidence. But how does he proceed? If we turn to page 35, he there adduces the remarks of Mr. Webster, Q.C., a gentleman wholly opposed to his views, and offers what he says to answer his own enquiry—"Who is to get a patent, since in *many cases* there is a *plurality* of almost *simultaneous* inventors?" Mr. Webster, in his evidence, which Mr. Macfie twists to answer his own perverted purposes, is speaking of similarity of patents "within two or three years," and some "within a year," and names as a singular instance "six patents almost within six months." But, in the name of common sense, what has all this evidence to do with "simultaneous invention"—the bug-bear and stalking horse of patent law abolitionists? Although they care not whether such is the case or not, yet it is worth their while, if they can, to pretend an interest in the disappointments of "simultaneous inventors," and in endeavouring to baffle the course of justice by affecting a belief in such nonsense. Were there two or three, or more, Watts, or as many Arkwrights, or Bramahs, or Perkins, or others? Such stuff was never heard until taken up by the Patent Law abolitionist party, who have puffed this silly assertion into a bubble of prismatic beauty and importance. We have no faith in, and we refuse to believe the assumed fact of "simultaneous invention"—meaning by simultaneous at the same time, or without suggestion, or previous knowledge of any kind. When an invention is once fairly before the world, then, indeed, two, three, or more men may by possibility "simultaneously" see some deficiency, to be supplied by some obvious alteration or addition. Thus Watt omitted to patent the crank, and, no doubt, many men *simultaneously* saw that the crank, as used for spinning-wheels, lathes, or grindstones, was an important thing to be added to Watt's patented engine. But who ever would think of calling these "simultaneous *inventors*," and plead the case of such petty improvers of another man's great work as one of the grievances of poor inventors? And yet lawyers repeat this silly argument of the abolitionists, and Mr. Macfie and all manufacturers adhere to it, in hopes to bring patents and inventors generally into contempt. To the same purpose he quotes Sir William Armstrong's evidence regarding—"An *idea* which is present in the minds of *very many persons* at the *same time*, without any reference to his competency to develope that *idea*, and to give it practical value, he is allowed to have a monopoly of it, and thereby to exclude all other persons." Such unsupported evidence is worth little, and in this case it is worth nothing. A man who patents a mere "idea," and that not "practical," his patent is of no value. It may be for a "perpetual motion," and for such moonshine Mr. Macfie and Sir William Armstrong (on his showing), or others, might obtain an iniquitous "monopoly of it [this precious *idea*], and thereby exclude all other persons." Such is Mr. Macfie's support of "simultaneous invention," than which nothing possibly can be more futile, feeble, and false.

Still harping on the misfortunes of inventors themselves, he observes:—"Mr. Webster shows how it is that men of science, the real *discoverers*, miss reward." Now, Mr. Webster shows nothing of the kind; there is no "miss" whatever in the matter, and it is taking most unfair advantage of his observations to represent him as suggesting "reward" for *discoveries* in science, which are principles or

laws in nature, open to be applied in thousands of ways, forming the groundwork of all inventions whatever.

No man's evidence is safe under Mr. Macfie's peculiar mode of treatment; thus he offers as a bad effect of patents, their "restraining of publication. Hear Mr. R. Roberts' *thrilling* representations." And what does the reader suppose that Mr. Roberts' "thrilling representations" go to prove? Why, nothing more than the very thing to which Mr. Macfie has given all his humble powers to show the contrary—that cheap patents are better than dear patents! Mr. Roberts says, "I have a list of something like 100 inventions that I should have patented 30 or 40 years (1830-40) ago *but for the cost*." This is, indeed, very "thrilling," and its appearance at p. 40 of Mr. Macfie's lumbering book is truly whimsical. Of course, Mr. Roberts was quite right; 30 years ago he must have taken out patents for 14 years, at heavy patent charges, but the modification he desired has come to pass, for now a patentee can secure his invention for the United Kingdom commencing with three years' protection, and proceed further or not, according to circumstances. Is it not, then, amazing to find Mr. Macfie contradicting himself at every point, while at the same time he speaks with all the boldness and self-satisfaction of one who is supporting a righteous cause? His comments on the evidence thus adduced, p. 40, are so extremely foolish that the only wonder is how so much nonsense could be seriously written. I adduce this evidence," he says, "to *prove* that inventions actually made are kept back just now." To which our natural enquiry is, "Then you would have patents granted at a cheaper cost?" But we know his reply would be, "Oh, dear no, nothing of the kind; I would not even attempt an 'improvement' of the law, as that would be but an 'alleviation.' I would have this iniquitous law altogether abolished." How, therefore, he reconciles this "thrilling" evidence with his professed object is beyond the power of common sense to conceive. This he follows up by his own experience of "a party" who has "two or three *small* inventions," but has no ready means to publish, and so has for years kept them back. Poor man! Let me recommend his at once publishing these *small* affairs in the columns of the *Mining Journal*. "But," he adds, "a more remarkable instance is present to my mind." Since 20 years an invention has been kept "secret," "it is ingenious, and *may be* practicable;" and, singular to relate, it "has never been patented or *thought of by anybody else* than he who confided the secret." Now, this is really refreshing, for we are no longer among "simultaneous inventions;" and we learn for a *certainty* what a wonderful power of second sight Mr. Macfie must possess. He has it in his power to assure the wide world that here is a secret of 20 years standing that has never even been "*thought* of by anybody else." This outdoes all ordinary spiritualism; for, while we always thought it was difficult to become acquainted with even the actions of others, here is one comes to the judgment who sees into the very *thoughts* of men.

But the most serious part of all is to "mark now how patents hinder progress in *manufactures*." Do you suppose sugar refining is affected, or sail-making, or copper, or iron, or steel, or indeed, any other? After much search Mr. Macfie advances the observations of Mr. Brunel, in respect to the Electric Telegraph Company. After this novel manufacture he says:—"The same is certified by Sir W. Armstrong," who, however, is only speaking of patents as affecting advance in invention. Therefore, Mr. Macfie breaks down in his promise to inform us "how patents hinder progress in *manufactures*." Mr. Brunel first says "I believe," then "I firmly believe," and concludes "I believe." But surely his belief is little short of prejudice, when given unsupported by a single fact. We want facts, but neither Mr. Macfie, nor Mr. Brunel, nor Sir W. Armstrong, supply other than their personal convictions, independent of facts, of which, however, they always lead us to infer that they have an abundant store.

To my mind, the difficulty in arguing with these short-sighted or self-interested patent abolitionists arises from their always treating of inventions as they now are, and their being unwilling or unable to foresee the future. Step by step we may go on improving from age to age, now the stone is once set rolling; but without patent law, greatly modified and improved, the progress of real invention will be heavy and sluggish indeed. Both the State and manufacturers benefit by inventors; but it seems to be the interest of manufacturers to become paupers to the State for the contributions of inventors.

London, Sept. 27. An Engineer.

THE MINERAL WEALTH OF PORTUGAL.

Sir,—In continuation of my subject, I now proceed to offer a few remarks on the two best of the late Portugal Iron and Coal Company's mines—Moita, in Arnal, and Cabeça do Coz—and I also propose to just touch on one or two localities of minor importance.

Arnal.—This concession, although one of the smallest, is certainly one of the most valuable of the original ten. It is the nearest to the Pinhal del Rey, the source of the fuel, and presents great facilities for making a tramroad. The outcrops, which induced the company to take the concession, turned out failures, but Mr. Lintern discovered a very fine deposit of rich ore, near a village called Moita; the outcrop at this place yielded a large quantity of ore from surface workings while the main shaft was being put down. This shaft was completed to a depth of about 70 feet, the last few feet being in a deposit of good hard ore, which presented all the features of a continuous bed, when the men were drowned out, it being found impossible to keep the water under without engine-power, which the company was not in a position to supply, and so the work had to be abandoned. Near to Arnal village are the remains of ancient iron works, and immense quantities of scoria; the place would, however, present more features of interest to the antiquary than to a man looking for iron ore, for near these slag tips the ruins of a magnificent villa (said to be Roman) were discovered. Fortunately, the Portuguese peasantry are not a destructive race, and some beautiful mosaic pavement is still to be seen. It was assumed that if the Romans (why is everything ascribed to them?), with their rough appliances for extracting ore and making iron, could succeed at all, and the slag tips evidence that they must have worked a long time, a modern company had only to re-discover the deposit of ore to make very handsome profits. Now this, I assert, was based on a wrong conception of the manner in which the Romans (assuming, for the moment, that it were the Romans) conducted their operations. History abundantly proves that—1, they conquered; 2, they exacted tribute and appointed receivers; 3, they allowed no abatement from the tax; 4, they usually adapted the nature of the tribute to the products of the conquered country. In the case of Portugal this tax would, I imagine, be payable in lead and iron.

Now, for the sake of argument, just suppose that the Peninsula was overun by the Romans, and the price of semi-independence or other privilege fixed at so much iron, what steps would the chief of each province take to ensure its prompt payment, and what reasons would he have to induce him to exert himself to the utmost? Why, in case of failure would he not be liable to death or captivity himself, and that would make him sufficiently unscupulous about the cost entailed on his subjects or serfs in bringing in ore. The first step would be to find a place with a good fall of water—now, the slag heaps of Arnal are adjacent to just such a fall of water as would be required to work a Catalan furnace. Secondly, it would be much more important that the site chosen should be near a forest than that it should be near the ore, wood and charcoal being much more difficult to transport than ore, in a primitive country, where there are no roads for wheeled traffic; and although there are no forests to speak of in the immediate neighbourhood of Arnal village, I conceive that this does not prove that there were not forests in time past—the absence of them rather proves that there has been a demand for fuel to a large extent. Thirdly, not having proper tools and appliances for mining, he would probably fix on a site where a quantity of ore was to be seen on the surface. Now, for a mile or two round Arnal village nodules of iron ore and some small beds of red hematite are to be found in the drift and soil. If cost were no object (and it was none to the Romans in a case of this sort) I would undertake to gather up from the surface alone 20,000 tons of good serviceable ore; this would have lasted them 100 years; and yet, in the face of all this, it is the fashion to point out old smelting-works as a sign that there must be a workable deposit of ore close by that the ancients worked, which will cost a mere nothing to find, and still less to work.

Surely it is a mistake to consider the presence of a slag-tip as indications of the presence of ore. I know that the ancient miners sometimes touched the outcrops of really large bodies of ore, as in the case of Lindale Moor and Furness, generally; but, then, these mines have never been idle; but no one in their senses would look for iron ore either at Backbarrow or Duddon, where there is plenty of slag from the charcoal-furnaces of Messrs. Harrison, Ainslie, and Co., and yet the slate here and there is stained with red hematite. A case which may throw some light on the subject occurred in the parish of Millom, Cumberland. The remains of an old furnace are, or were, visible a few years ago in a field in Millom Park. Close to this field the soil and rocks are stained with iron ore. Some persons were persuaded that they might make their fortunes with a ridiculously small outlay, by discovering the lost mine which had supplied the furnace. A shaft was sunk, and, a little ore being found, preparations for working on a grand scale were commenced, and machinery put down; but, alas! no more ore was forthcoming. Another company was formed, about the same time, I believe, to search for iron ore on the strength of natural indications, at a place about three miles from the former, and, after immense perseverance, succeeded in finding a deep deposit of ore, which appears to be practically inexhaustible. They are now raising upwards of 1000 tons per day. I am convinced that Moita and Arnal are in the same relation to one another. Cabeça do Coz, 15 miles from the works, and 1½ from the Marinha Grande and Sao Martinho Railway, to which a self-acting tramway could be constructed at a very moderate cost, was not one of the "Croft" concessions; it was taken up direct by the company, and in all probability would have proved a very valuable property. A quantity of serviceable ore was obtained from open works, and a trial shaft was sunk, which gave such favourable results that it was decided to drive a deep adit, which, unfortunately, was stopped, through the failure of the company, before it reached the point at which it was expected to meet with the ore, thus proving nothing definite. These trials showed all the indications of leading to a good paying mine. It would, of course, cost something to develope it, but when that is done a continuous supply of ore might be expected for years to come. One sample taken from this mine was assayed at the Royal College of Chemistry, and declared to be pure turgite, equal $94{\cdot}7\,F^2O^3\,15{\cdot}3\,H^2O$.

Marazes, Pinheiros, Baroza, and Sao Miguel, which are close to Leiria and about eight miles from the works, severally gave a little ore, but not one presented features equal to Coz or Moita; Lovegados, 15 miles north of Marinha, yielded about 200 tons of red ore, containing 40 per cent. of iron; the ore was found just under the sand (a part of the vast expanse I mentioned in my first letter), and at first had the appearance of a regular lode, but on investigation proved to be only 3 or 4 fathoms long, and although 6 ft. broad on the top, it nipped out to nothing at a depth of 4 or 5 ft., or, perhaps, a little more. Monte-real, six or seven miles nearer the works, presented a series of false bedding, a bed or two of brown ore occurring here and there; in one bed of decomposed shale crystals of martite were found (Fe^2O^3), principally octahedrons and rhombic-dodecahedrons, the striations on the faces and the bronze tarnish were finely developed.

In conclusion, I beg, Sir, to offer you my best thanks for the opportunity you have afforded me of giving your readers an outline of the information I acquired during my residence at Marinha Grande during the years 1866-67, which I trust will prevent them being led blindfold into any future company; and I may add that I was most favourably circumstanced to form a cool and dispassionate opinion, and that opinion is this—that no man who has carefully investigated all the circumstances of the country, modes of access, and the present sources of fuel which have to be competed with (provided that he possesses the slightest knowledge of practical mining, or is experimentally acquainted with the calorific power of the different kinds of fuel) could or would recommend anyone to attempt to utilise the Leiria lignite or *coal*, which does *not exist* in any quantity, and which, taken as a whole, is *not good* in quality. The iron ore, I believe, would pay to work, provided it were made into *charcoal* iron in the neighbourhood; the pine in the Pinhal del Rey makes most excellent fuel, and with a little judicious management a continuous supply could be obtained for years. Before I conclude I should like to mention that the furnace at Marinha Grande has lately been at work smelting ore brought from Monges, a mine in the Alemtejo, with the most satisfactory results, both as to yield and quality.

E. Heydelbach Davis, F.C.S., F.G.S.

West Brompton, Sept. 28.

THE MINERAL WEALTH OF PORTUGAL.

Sir,—It is no part of my purpose in writing again under the above heading to enter into an acrimonious discussion with Mr. King, and my object in writing my former letter was to disabuse him of some of his self-confidence in entering upon a description of works and districts of which he clearly cannot have any personal acquaintance. However it may "smack" of temerity in Mr. King's estimation, I assure him that I do say and maintain that there is no "coal" to be seen in any "cliff" near Marinha Grande. There are no "cliffs" near Marinha Grande in which coal *can* appear, for, for miles around that place there is no sign of a rock coming to the surface, but sand everywhere, which he could not easily forget were he to spend three months in any year at that place, from the end of June to the end of September, when the hot, dry, loose sand everywhere around is painful to walk over. I also maintain that close to Leiria there is no coal formation, unless it lies deep down in the earth; and if it does occupy such a position, neither Mr. King nor any other person has as yet seen it. If I did not see Mr. King's fuel in the office, I saw, as I said before, what was shown me as such. I have no other proof of its having been so. As to the experiment at Lisbon, in the furnace of the Cornish boiler (as related last week by Mr. King), it is quite clear that 5½ kilos., or (say) 12 lbs. of the fuel, could not of itself make a fire under a Cornish boiler, therefore the conclusion is unavoidable that this block of fuel was put into an incandescent fire under the said boiler; and I leave it to any practical man to say of what earthly value is such an experiment, or what it proves, or how it could avoid being consumed, unless it were a stone itself, or something very like it. As to the two local directors having been satisfied with the experiment, I can only say that as neither of them had any practical knowledge of the subject their expression of satisfaction goes for nothing.

Mr. King reminds me of the old adage, that "they who live in glass houses should never throw stones." I suppose that this adage is brought to his mind by reflecting upon the matter of his first letter, and that it is the expression of his sorrow for having commenced the game of "stone throwing." Perhaps he discovers that some of his glass is being broken. I must in charity suppose that he has gleaned his information from gentlemen in Lisbon and elsewhere, and not on the spot, or he could not have written such nonsense as that of "coal in the cliffs near Marinha Grande," nor of a "coal formation close to Leiria;" and he is not the first that has been misled by tales of this kind given of different districts, but which exist only in the imagination of interested persons. Other companies besides the late Portugal Iron and Coal Company have bought what never existed, and paid dearly for it, as they did: 40,000*l.* in shares and cash was paid for what 5000*l.* would have been full value, and perhaps too much. Many tales were told of veins of coal of respectable thicknesses having been found at Chao Preto by the original concessionaire, but they existed in some pass which was then full of water, or in some borehole made recently; but when I went to work to "disembowel the riches" they were *non est*. It was possible, I admit, to gather specimens of coal, some of them, perhaps, weighing 5 or 10 lbs., but no clean vein of any thickness possible to work to any practical advantage was obtained. The vein in No. 3 level, mentioned by Mr. Davis in his letter, was thrown by a fault into a position which caused it to cut the regular dip of the strata at right angles, and in consequence of this heave an increased thickness had been given to it—about 10 in. It was very much like Cannel coal, and was very full of gas, as was evident when it was being burnt in the smiths' forge, for we obtained all we could of it.

The stratum for which we were driving in No. 3 level, and which looked so promising at the outcrop, did not improve in depth, as we had hoped it would; and, having driven through it, and finding it of no commercial value, I did not hesitate to recommend that the trials for coal at this place be abandoned, much as I regretted the result. To have obtained anything from the stratum found it would have been necessary to crush the whole of it together, and then wash out the carbonaceous portion from the shale, for it was so intermixed, and the coaly matter bore so small a proportion to the shale, that the separation by hand picking was out of the question. So much for Chao Preto coal.

At Marazes, as I said before, was the lignite bed, but as to its extent nothing is known. There were some records of borings, purported to have been made in the neighbourhood, which were intended to show that the field of lignite was large, but to my judgment no reliance could be placed in such records, and they were made before the concessions were sold to the company. There is no doubt but that a considerable quantity of lignite could be obtained here, and I would hesitate to say that no good could be done with it, but it was overlaid by about 20 ft. of sand and clay, and that thickness rapidly increasing as the bearing was proceeded with further back, which was no slight matter. The upper portion of this bed was so interlaced with the trunks of trees, some of 30 feet in length, and which retained their woody structure well, that an attempt to mine it by driving into it under the "topping" was not made, although I was anxious to try that method, and I have no doubt but that the attempt would have been made but for the "death" of the company—a death which was purely accidental, and in no way brought about by gradual decay and exhaustion.

In the Pinhal Real, or Royal Pine Forest, about five miles from Marinha Grande, and about 1000 yards from the sea shore, was a course of brown coal in a sand bank, on the side of a small stream of water, and I was taken to this place to see what could be done with it. I took men, and had the brushwood cut away, and a "cut" made into it, that I might see what it looked like. I found it overlaid with sand, which had no cohesion whatever, *inter se*, and a like material for the floor; the roots of the large pine trees descended through the sand to near the top of the bed, and as the wind rocked the trees the leverage upon the roots made them to keep the sand when undercut in constant running action; added to this, the brown coal had no cohesion, *inter se*, itself, but was cubical and dry, like so many dice piled into a bed (and seemed to partake somewhat of the nature of jet), so that leaving up any portion to sustain the top was impracticable. These I consider to be formidable difficulties in the way of working it to a profit, and I did not feel that I could recommend its being being proceeded with. And, in addition to the above, there was yet the question of disposing of it, or bringing it to market after it was mined, and the way proposed to us was to send it to the beach in ox-carts, there to load it into lighters, and then send it out to a vessel that was to be anchored at safe distance out at sea, then to take it to Lisbon, about 80 miles; and considering that there was a heavy swell at the best of times on this Atlantic shore, and sometimes very heavy, and no harbour near, it was an undertaking that even Mr. King would not have looked upon with unmixed pleasure had he to undertake to carry it out, and be required to produce to the coal in Lisbon at a figure that would command a profit on the transaction. At any rate, I was wanting in courage to undertake such a work.

My conclusions upon Espite, after carefully examining the district, were given by Mr. Davis, in the Journal for Sept. 18. When speaking of Peste, Mr. Davis gave the thickness of the "outcrop" as 3 feet; this was a mistake, as it is only 2 feet thick. To mine it underground is simply impossible, as it has sand and clay both over and under, and the bank of "topping," rising from the stream of water in which it is seen, increases to such a great thickness that to bear it off for 2 feet thick of lignite *could not pay*. The other outcrops of lignite, so far as they have come under my notice, are unworthy of comment.

Such, Sir, is my experience of the "coal in the cliffs," "coal formation," &c., in the concessions held by the late Portugal Iron and Coal Company, and I am afraid I have, perhaps, tired you in being so lengthy in my description of them; but I could not well be more brief, and the statements of Mr. King seemed to call for an account by some one who knew the district very much better than he possibly could have known it when writing the letter that called forth these comments.—*Pontypridd, Sept.* 28. Wm. Lintern.

[For remainder of Original Correspondence, see this day's Journal.]

FOREIGN MINES.

United Mexican.—Guanaxuato, Aug. 21: Mine of Jesus Maria y Jose: The frentes in the bottom workings, called San Lucas, San Carlos, and San Modesto, are in low ore, and with the work on our reserves give us about 500 cargas weekly for the haciendas. Very little change has taken place in all these workings since the date of my last report. The buscone works are in a very fair state; the ore in them is narrow, but it is of good quality, and the immense numbers of workmen who have flocked to the mine have brought our sales up on Aug. 5 to $2798; on the 12th to $2367; and on the 19th to $2625. The unusually wet weather has thrown back our operations in the haciendas, and in July we only washed two tortas, for which reason the Jesus Maria and Remedios accounts show unfavourably in the last month, and there is an apparent loss of $3859 on the former mine.—Mine of Remedios: The northern frentes of San Eligio have fallen off. San Christobal has also declined, but is improving again. San Joaquim is all in ore about 6 varas broad, but the class is not so good as it was in San Eligio below. We are gradually opening out in this ground, and there is a good deal of ore in sight. The sales have been—On Aug. 5, $1134; on Aug. 12, $754; and on Aug. 19, $915. The ore sent to the haciendas averages from 260 to 300 cargas a week. The accounts for July are unfavourable, and show a loss of $455. In August they will be good, as we have washed two tortas, and have a raspa in from Dolores worth nearly $6000, so that on or after Aug. 31 we shall be able to make up the quarter's accounts showing a fair profit.—New Concern, Adit of San Cayetano: We have driven through a lode this month which is not well defined, and does not look promising; it cannot be the vein of La Loba yet. The ground is not so hard as it was, and we are getting on faster.—Mine of Buenos Ayres: The rock in the shaft continues hard, though the water is less troublesome. To-day we have reached a depth of 85¼ metres.—Mine of San Antonio de la Ovejera: The rock in the shaft has been better for advancing, and to-day we have reached a depth of 120¾ metres.

Imperial Silver Quarries.—L. Chalmers, Sept. 6: Twelve feet of tunnel were made last week. Still in porphyry, interspersed with occasional pockets of gypsum, carbonate of lime, and sulphate of baryta.

Lusitanian.—Sept. 21: The lode in sinking Taylor's engine-shaft below the 130 is worth 2 tons of ore per fathom. In No. 79 winze, below the 120, west of Taylor's, the lode is worth 1 ton of ore per fathom. In No. 78 winze, below the 8, west of Perez' shaft, on branch, the lode is 8 in. wide, yielding stones of ore. In the 130, east of Taylor's, on Basto's lode, the lode is 5 ft. wide, composed of country and a little flookan. In the 130 west the lode is 2 ft. wide. In the 120 east the lode is 4 ft. wide, composed of runners of country and quartz. In the 120 west the lode is 1 ft. wide, composed of quartz. In the 110 east the lode it 1½ ft. wide, composed of flookan. In the 90 east the lode is 1½ ft. wide, composed of flookan. In the 70 east the lode is 3 ft. wide, composed of quartz and flookan. In the 70 west the lode is 1 ft. wide, of quartz and small stones of ore. In the 28, east of cross-cut, west of Perez' shaft, the lode is 1 ft. wide, worth 1 ton of ore per fathom. In the 20, west of cross-cut, west of Perez' shaft, the lode is 6 in. wide, yielding very small stones of ore. In the 18, east of cross-cut, the lode is worth ½ ton of ore per fathom. In the 18 west the lode is in two branches, worth together 1 ton of ore per fathom. In the 8, west of Perez' shaft, the lode is 6 in. wide, producing stones of ore. In the adit level west the lode is unproductive.—Ponte Lode: In sinking the winze below the adit level, west of River Caima, the lode is 1½ ft. wide, and worth ½ ton per fathom.—Carvalhal: In No. 10 rise, above the 40, east of incline, the lode is worth 2 tons of lead and blende together. In the 50, east of incline, on great lode, the lode is 1½ ft. wide, composed of quartz and stones of blende. In the 40 east the lode is worth ¾ ton of lead per fathom. In the 30 east the lode is 1 ft. wide, composed of flookan and quartz. In the 20 east the lode is 2 ft. wide, composed of quartz. In the 10 east the lode is 2 ft. wide, composed of quartz and country.

[For remainder of Foreign Mines, see this day's Journal.]

Manufacture of Iron—New American Patents.—Mr. Wm. M. Lyon, of Pittsburg, claims the mixing of solid carbon with iron ore or other oxide and melted pig metal, in the formation of the conglomerate known as "pig-bloom" or "pig scrap," in such manner and in such proportion as to reduce the excess of oxides in the conglomerate, and thus lessen the formation of cinder, and increase the yield of malleable iron, in the process of treating the conglomerate preparatory to rolling or hammering the iron.—Mr. Lyon also claims—1, in the manufacture of wrought-iron the production of a solid mixture, or conglomerate of cast-iron and anthracite coal, charcoal, coke, or other like substances containing a large percentage of carbon, by so uniting or intermixing the molten iron and crushed or pulverised carbonaceous matter that such uniting or intermixing shall result in a solid product, substantially as above described; 2, as a new article of manufacture, a solid mixture or conglomerate of cast-iron and carbonaceous matter, produced by uniting or intermixing with cast-iron in a fluid state, crushed, pulverised, or finely-divided anthracite coal, charcoal, coke, or other like carbonaceous substances in a solid state, in such manner and in such relative proportions as to produce a solid product.—Mr. John Burt, of Detroit, claims—1, the manufacture of "crude bloom," by mixing the molten or cast metal and oxidising or carbonising agents employed in a closed or open crucible or mould, substantially as and for the purposes set forth; 2, maintaining the heat in the crucible during the formation of the "crude bloom," by heating the same externally, or by mixing suitable heating agents with the mass within the crucible, substantially as and for the purposes set forth; 3, the employment, in the manufacture of the "crude bloom," of a closed reversible crucible or mould, to effect the thorough mixture of the ingredients placed within it, substantially as set forth; 4, the mixture, within a closed or open crucible, of the molten cast metal, with a mixture of oxides, fine cast or wrought scrap and carbons, for the purpose of increasing the quantity of the metal in the "crude bloom," substantially as herein set forth.

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